latter name has the priority of date, and of the two localities given for the species, viz., India and New Holland, the second is no doubt erroneous.

The Fabrician species *Lamia rotator* (*Monohammus rotator* of the Munich Catalogue) is, as I find from the type in the Banksian Cabinet, identical with the North-American species *Goes tigrinus*, Degeer. The locality—India or.—given by Fabricius, is of course wrong. As both descriptions —the Fabrician and that of Degeer—appeared in the same year, it is doubtful which has priority of date. Degeer's name being better known, and his description being fuller and accompanied by a figure, there is no reason why it should not be retained, and the Fabrician name sunk into a synonym.

XXXV.—*Researches at the St. Andrews Marine Laboratory (under the Fishery Board for Scotland). — On the Embryology of the Retina of Teleosteans.* By Dr. R. Marcus Gunn, M.A., M.R.C.S., Surgeon to Moorfields Hospital, London.

In the investigations hitherto made on the development of the eye in the bony fishes the ova of freshwater forms have been employed. I am indebted to Professor M'Intosh, F.R.S., for an opportunity of examining carefully prepared sections of embryos of marine Teleosteans, which he had succeeded in maturing in the St.-Andrews Marine Laboratory.

Several causes combine to render accurate results more difficult of attainment in the case of fish than in other instances where ova can be watched during maturation. Not only do the ova of fish vary much in the rapidity with which they mature after impregnation in different genera and species, but even in the same species, according to external conditions, especially the temperature of the water. Indeed, Professor M'Intosh tells me that in the same series of ova, matured under identical conditions, some individuals develop more quickly than others. Great diversity, moreover, obtains in the stage of development attained before hatching in different fish, and even to some extent in different individual ova of the same fish.

I have consequently been obliged to base my calculations of advance in development simply on histological features

observed, although the remarks made on the slides at the laboratory as to the age of the ovum are also very valuable as a guide.

In this way I have examined preparations of the following ova:—

1. *Gadus æglefinus*:

(1) 2nd day after fecundation.
(2) 4th „ „ „
(3) 9th „ „ „ (Several.)
(4) 14th „ „ „ (Several.)
(5) 17th „ „ „
(6) 2nd „ „ emergence. (Several.)
(7) 3rd „ „ „
(8) 4th „ „ „
(9) 6th „ „ „
(10) 8th „ „ „
(11) 14th „ „ „
(12) 17th „ „ „

2. *Gadus merlangus*:

9th day after fecundation.

3. *Gadus morrhua*:

2nd day after emergence.

4. *Liparis Montagui*:

"March 11, 1885." ? Age.

5. *Gastrosteus spinachia*:

(1) About to emerge. ? 4th week.
(2) Later specimen.

6. *Cyclopterus lumpus*:

(1) "A Embryo." ? Age.
(2) "June 16, 1885." ? Age.
(3) "No. 1 slide." ? Age.
(4) "July 2, 1885." ? Age.
(5) Just emerged. (Several.)

7. *Anarrhichas lupus*:

Many specimens examined, marked "January," February," "March," "April," "May," "June."

8. *Molva vulgaris*:

(1) "May 8th." ? Age.
(2) "May 10th."

9. *Trigla gurnardus*:

(1) 4th day after fecundation.
(2) 13th ,, ,, ,, 3rd day out.
(3) 6th ,, ,, emergence. (Several.)
(4) "June 30th, 1886." ? Age.
(5) "July 25th." ? Age. (Several.)

10. *Cottus*, ? species:

(1) "April 6th, 1886." ? Age.
(2) "April 7th, 1886." (Several.) ? Age.
(3) "April 13th, 1886." ? Age.
(4) "April 14th, 1886." ? Age.

11. *Pleuronectes flesus*:

(1) 9th day after fecundation.
(2) 10th ,, ,, ,,
(3) 11th ,, ,, hatching (?).
(4) "May 18th, 1886." ? Age.
(5) "June 18th, 1886." ? Age. (Several.)

I also examined ova of *Salmo salar* at the following stages:—

(1) 40 days after fecundation.
(2) 1st day after emergence. (Several.)
(3) 13th ,, ,, ,,
(4) 45th ,, ,, ,,

Very briefly, my conclusions may be stated as follows:—
The first appearance of the Teleostean eye consists in a solid outgrowth from the brain, which latter is at this stage itself also solid, and both structures are formed of cells similar throughout.

A little later a cavity first becomes visible on the optic outgrowth and on the central nervous mass, and consequently at this stage the developing eye may, for the first time, be truly described as an optic vesicle. The outer wall of this vesicle is about twice the thickness of the inner, the former being about four cells and the latter about two cells deep. The cells in both walls are similar in appearance, being of an oval form and uniform size, and they are arranged radially, *i. e.* with their long axes perpendicular to the slit-like cavity. The only exception to this arrangement is anteriorly and posteriorly, where the two walls become continuous with one another; in these situations the radial disposition seems not to exist. The nuclei of the inner wall of the vesicle are rather more deeply stained than those of the outer. The cells of the developing brain are very like those of the optic vesicle, and are similarly arranged in relation to its central cavity. At this stage is also observed a slight thickening of the deep layer of the cuticular epiblast corresponding to the position of the future lens; but this is not so far advanced as to indent the outer wall of the vesicle. A prolongation of cells from the same deep layer of cuticular epiblast is now observed lining the sides and base of the optic vesicle, so as to separate it from the brain.

The cavity of the optic vesicle seems soon to disappear, for at the next stage examined, while there are few important changes, there is only a faint line of separation between the outer two thirds and the inner one third of the cells. Internal to the vesicle there is a double layer of elongated cells, their long axes being parallel to the wall of the vesicle. One of these layers follows the curve of the vesicle, while the other (inner) layer is closely applied to the central nervous mass. Where the rows diverge anteriorly large cells from below the cuticular epiblast dip into the angle so formed. The lens develops rapidly and is already well advanced, indenting the outer wall of the optic outgrowth, and so forming a "secondary" optic vesicle. At this stage no pigment-granules are discernible.

Differentiation now soon occurs in the optic outgrowth, so as to indicate roughly the position of the future layers. We may therefore in future speak of it as "retina," and describe the position of the layers in relation to the secondary optic vesicle or optic cup instead of to the outer wall of the embryo as we have hitherto done. A series of elongated deeply staining cells, arranged closely side by side and with their long axes radial, form a single row most externally in the

retina. Though longer than any others in the retina, these cells are as yet comparatively short; their nuclei are large. These represent the future retinal sight-epithelium, a layer of rods and cones with their nuclei. The inner mass of cells remains for a short time unchanged, except that midway they are more loosely placed, indicating faintly a line of separation between its outer and inner halves. Between this cell-mass and the future cone-layer there is a distinct space, corresponding to the position of the late vesicle-cavity and of the future outer molecular layer. Internally the retina is indistinctly bounded by a line, showing the foundation of the layer of nerve-fibres, for fibrillation soon becomes distinct in it near the optic nerve entrance. In the cells previously described as occurring between the optic outgrowth and brain, and which now appear (on section) long-oval and flattened horizontally, pigment-granules begin to form. When first visible these granules closely surround the cell-nucleus only, the remainder of the cell being free. The pigment forms first in the cells at the anterior and lower part of the fundus of the eye, and in those cells in front of the periphery of the lens which correspond in position with the future iris. In one or two preparations this pigment-layer was accidentally turned over to some extent in cutting the sections, and we thus obtain a surface view; the cells are now seen to be of good size, flat, with large nuclei, and arranged as a pavement-epithelium. About this time pigment also begins to appear here and there over the brain, especially anteriorly, occurring in the flat cells previously described. Both here and round the retina therefore the pigment is formed in cells derived, I believe, from the deep layer of the cuticular epiblast, not, in the case of the Teleostean eye, from the inner wall of the optic vesicle. To be confident on this point, however, further observations are necessary, and especially a complete series of preparations of ova of one species, a desideratum that can only be satisfied by a marine laboratory such as that of St. Andrews.

A finely granular layer (internal molecular) next appears on the large cell-mass, dividing it into a smaller inner and larger outer part. At first both sets of cells are about the same size; but those internal to the inner molecular layer soon become distinctly larger than those outside it; the former represent the ganglion cell-layer, the latter the layer of inner granules. The outermost cells of the inner series very soon become distinct from the others, staining more deeply and being arranged in a regular single row. About

the same time the segments of the cones become visible. We have now six retinal layers, distinguishable by the following characters :—

1. *Cone-layer.*—Vertically placed, elongated, deeply staining cells, with very slight, fine, clear projections from their outer extremities. Their bases stain most deeply.

2. *External molecular layer.*—No longer clear, but now forming a distinct, thin, dark, finely granular line.

3. *Inner granules.*—Cells about six deep.

4. *Internal molecular layer.*—Uniform, rather thick, non-staining.

5. *Ganglion cell-layer.*—Cells about four deep and rather larger than the inner granules. Distinct one-celled row externally.

6. *Nerve-fibre layer.*—A thin, non-staining streak, with horizontal fibrillation just evident.

The *pigment* occurs in distinct, flat, horizontal, long-oval deposits. These nearly all touch one another, so as to form an almost continuous layer traceable forwards to the iris.

Outside the pigment layers of fibrous-looking tissue are now formed, which can be traced forwards to the front of the equator of the lens, where it is anterior to the pigment of the future iris. This is a mesoblastic formation forming the iris, choroid and sclerotic. The cornea is still very thin, apparently consisting as yet mainly of epiblastic structures.

A single row of horizontally-flattened cells next appears just internal to the outer molecular layer. The inner molecular layer becomes broader, and soon shows a distinct, fine, dark, median band. The ganglion-cells further increase in size. The pigment develops rapidly, and soon sends down processes between the segments of the rods and cones. An external limiting membrane now becomes visible. The cornea also shows intrusion of mesoblastic elements into its central part, and a further thin process of mesoblast lines it internally, forming Descemet's membrane. In the marine Teleosteans the vitreous chamber is late in developing, but shows itself about the stage now reached.